Technology
Arts Sciences
TH Köln

# Course Manual ACC

Advanced Channel Coding

Version: 2 | Last Change: 06.08.2019 21:55 | Draft: 0 | Status: vom verantwortlichen Dozent freigegeben

## General information

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|---|---|
| **Long name** | Advanced Channel Coding |
| **Approving CModule** | ACC_MaCSN, ACC_MaTIN |
| **Responsible** | Prof. Dr. Uwe Dettmar<br>Professor Fakultät IME |
| **Valid from** | summer semester 2021 |
| **Level** | Master |
| **Semester in the year** | summer semester |
| **Duration** | Semester |
| **Hours in self-study** | 78 |
| **ECTS** | 5 |
| **Professors** | Prof. Dr. Uwe Dettmar<br>Professor Fakultät IME |
| **Requirements** | basics in linear algebra<br>basics in stochastics<br>good programming skills |
| **Language** | English |
| **Separate final exam** | Yes |

### Literature


R. E. Blahut. Algebraic Codes for Data Transmission. Cambridge University Press, Cambridge, 2003.

S. Lin and D. J. Costello. Error Control Coding. ISBN 0-13-042672-5. Prentice-Hall, 2004

T. M. Cover and J. A. Thomas. Elements of Information Theory. Wiley, New Jersey, 2006

A. Neubauer. Kanalcodierung. Schlembach, Wilburgstetten, 2006.

R. Roth. Introduction to Coding Theory. Cambridge, second edition, 2006

B. Sklar. Digital Communications. Prentice Hall PTR, Upper Saddle River, New Jersey, 2001


### Final exam

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| **Details** | Form: written exam (optional: oral examination)<br>- Duration: 90 minutes<br>- Assignment: in general 3 problems with subtasks which test on different taxonimies - different taxonomies are rated according to their complexity and difficulty<br><br>Note: the students can collect 25% of the total score from the two electronic intermediate tests. It is assumed that this promotes a continuos learning process. |
| **Minimum standard** | Basic knowledge can be adequately applied to known and related problems. The execution is in parts faulty. (4,0) |
| **Exam Type** | EN Klausur |

## − Lecture / Exercises

### Learning goals

| Goal type | Description |
|---|---|
| Knowledge | The underlying concept of this module is a combination from lecture and tutorial. After a lecture block of approximately 20 minutes) the subjects taught are actively trained using Matlab/Octave and Python programs.<br><br>Syllabus:<br>- Introduction<br>- Basic terms and definitions<br>- short history of channel coding<br>- System and channel models<br>- Review of binary error correcting block and convolutional Codes<br>- Generator and Parity check matrices,<br>- decoding principles, Trellis and Viterbi Algorithm<br>- Some principles on Information Theory<br>- Channel coding theorem<br>- Channel capacity and example calculations<br>- Cyclic Codes, Reed Solomon Codes<br>- Encoding and Decoding, Euklidean and Berlekamp-Massey - Algorithm for Decoding<br>- Basics on LDPC, Polar, and TURBO Codes<br>- iterative decoding, Sum Product Algorithm<br>- Recursive Convolutional Codes<br>- Performance comparison<br>- Basics on Space Time Coding<br>- Channel Model, Capacity improvement, Alamouti Scheme, STBC and STTC and their decoding<br><br>These subjects are presented during the lecture. Students shall deepen their knowledge by self-study of literature and internet ressources and discuss their results in small learning groups as a teamwork. |

### Special requirements

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| **Accompanying material** | lecture slides, problems and solutions, course page in the Ilias learning platform, collection of links, Matlab and Python programs, scriptum |
| **Separate exam** | Yes |

### Separate exam

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|---|---|
| **Exam Type** | EN Übungsaufgabe mit fachlich / methodisch eingeschränktem Fokus unter Klausurbedingungen lösen |
| **Details** | The success of the learning priócess is tested by two midterm tests. These tests consists of multiple choice and numerical questions and are implemented in the Ilias learning platform. By these two tests students can collect up to 10 points for their final score to raise their motivation for a continuous participation. |
| **Minimum standard** | 40% of the total score in each test. |

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| Skills | By the help of small exercises and programs during the presence time, students are able to actively train their knowledge. More extensive problems are solved and discussed in the second part of the course to activate the student's capabilities to solve relevant problems.<br><br>Students further learn<br>- to analyze communication systems and to estimate their performance<br>- to compare and rate algorithms and methods<br>- to apply their knowledge to technical problems |

## Expenditure classroom teaching

| Type | Attendance (h/Wk.) |
|---|---|
| Lecture | 2 |
| Exercises (whole course) | 1 |
| Exercises (shared course) | 0 |
| Tutorial (voluntary) | 0 |

## − Practical training

### Learning goals

| Goal type | Description |
|---|---|
| Skills | Existing simulation Tools like, e.g., the Matlab Communications Toolbox or AFF3CT (aff3ct.github.io) are used to:<br>- test theoretical results from lecture and tutorial<br>- implement algorithms for error control coding<br>- simulate BER and rate the performance, compare schemes<br>- adapt programs to solve equivalent problems<br>- become familiar with standard simulations tools<br>- train cooperation in small teams<br><br>Students learn to generate, check, present, and discuss performance results for FEC codes. They need to search for and<br>to study scientific literature as background sources for their simulations. Teams of students get different code families to study. Results are presented to the whole group. |

### Expenditure classroom teaching

| Type | Attendance (h/Wk.) |
|---|---|
| Practical training | 1 |
| Tutorial (voluntary) | 0 |

### Special requirements

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|---|---|
| **Accompanying material** | - problem formulation<br>- presentation of requirements and deliveries |
| **Separate exam** | Yes |

### Separate exam

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|---|---|
| **Exam Type** | EN Projektaufgabe im Team bearbeiten (z.B. im Praktikum) |
| **Details** | Present results in a 10 minutes talk and write a short paper to train the capability to publish in journals or proceedings. The paper is reviewed by a partner group. |
| **Minimum standard** | the required deliveries are generated. Presentation and paper are acceptable regarding form and content. |